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department of chemistry here; many links of friendship already bind our faculties; our joint efforts to advance the ideals of chemical research and instruction will surely cement still closer these ties!

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*TEACHING OF CHEMISTRY IN STATE
UNIVERSITIES*

A NEW epoch in chemistry has begun in the United States. Development along the lines of pure, industrial and applied chemistry is everywhere evident. The interest now taken by our universities, by our great industries and especially by our national government, bears evidence of wonderful progress. During the past decade, however, the Americans have asked themselves why other countries which can not be compared with our own in wealth and natural resources have surpassed us in nearly every phase of manufacturing and industrial chemistry. Indeed we can not understand how it has come about that the United States, by far the richest country in the world, is so far behind Germany in nearly all lines of manufacturing chemistry.

To one familiar with the European and especially the German industries, the answer seems comparatively simple, depending upon only a few principles, some of which I wish to briefly preface at this time. Germany leads the world in chemical industry, because of her persistent scientific study of every phase of industrial work. For nearly a century her watchword has been "science, industry and economy." She has spent all of her energies along applied chemical lines, and has brought to bear every possible resource which could be utilized in the furthering of her manufacturing conquests. She has long since realized the fact that to take an active part in the industrial world power, she must

match her science against the wealth and natural resources of other rich countries like our own. That she has succeeded is borne out by a glance at her export statistics.

By far the most important factor in the development of the chemical industries in Germany has been her universities. The German universities have perhaps cost the nation more than any other one institution, except her army. Unlike German militarism, however, the universities have been the best financial investment the nation has ever made. For two hundred years these great universities have been the nerve centers, yea, even the very brains, of the whole nation. During the last century they have played a unique and important part in this wonderful industrial development. Without them, her mineral industries would not be worth a passing consideration. Without them, her coal-tar, her beet-sugar and scores of other great industries would, in all probability, barely exist to-day. Without them, Germany would still be a fourth instead of a first class industrial power. Without them, I doubt if the nation could have lived through the fierce storms which have, from time to time, swept over the empire. Without losing the dignity of the university, without losing the highest ideals of scholarship, they have joined the purely scientific with the commercial side of the nation, bringing about conditions which have completely changed the life, the financial and social conditions, of the nation. This wonderful change has been brought about as Van't Hoff has well said, "entirely by a hearty cooperation between the scientific laboratories of the nation and the technical and industrial work."

But other nations have universities. Why have they not done for their respective countries what the German universities have done for Germany? The United

States, for instance, has more universities than Germany. Why then is the United States behind Germany in this industrial race? The answer, I believe, may be found in the fact that the American universities and colleges as a whole have not until recently fully realized the fact that the old idea of scientific culture in this present materialistic age is not what is demanded by the nation. University men now fully realize that scientific training of the old culture type, and more especially in chemistry, is worthless to the nation and worthless to the individual except in so far as the mental discipline goes. But simple discipline is not the sole aim in the study of any science. It must embrace experience and a true knowledge of the subject, such as will enable the individual to apply the principles in practical life. It is only when this training is applied that its full value is appreciated by the individual himself and by the nation. Didactic chemistry as taught twenty-five or thirty years ago can no longer be accepted by the universities of to-day. A glance into the history of chemistry will show that no scientific investigation has ever been made, either in the so-called field of pure or in that of industrial chemistry, which has not had its influence on the material development of the world. In fact, a discovery in chemistry or, as a matter of fact, in any other science which does not leave its impression upon the world, which does not help to bring humanity nearer ideality, from both the social and industrial standpoint, which does not directly raise the standard of civilization, is not worthy of being called a discovery. Our universities and colleges as a whole do not at the present time fully appreciate this fact. Our universities are just learning that the scientist and technologist are not born, but made by half a life-time of hard study, and that the universities alone are able to offer this scien-

tific training. The teaching of science in our universities, therefore, is paramount in the industrial and material development of our country.

In taking up the teaching of chemistry in the United States, I can not, I think, do better than to give a brief outline of the conditions under which chemistry has been taught in some of our state universities during the past twenty-five years.

It is a striking but lamentable fact that until the last few years the practical chemist of the United States was essentially a self-made man. He had perhaps taken a course or two of chemistry in his university or college, but rarely had he studied chemistry from the applied standpoint. Therefore, after graduating he was compelled to begin as an apprentice and to spend several years in learning the things which should have been taught to him in his university course. University work twenty-five years ago meant, in a large majority of state universities, the study of Latin, Greek, mathematics and history, with a smattering of modern languages. Seldom did a university curriculum include the study of science except so far as it represented simple didactic training. Applied chemistry was not considered worthy of being placed in the college curriculum.

I distinctly remember my first impressions of chemistry, as offered in one of our state universities. We studied general chemistry by the old didactic methods. Our first lesson was to commit to memory the atomic weights of the common elements. (Imagine a man in the University of Illinois spending the first week of his general chemistry course in committing to memory the atomic weights.) We had no laboratory experiments except those performed by the professor, and these were performed in such a way that the underlying truths were entirely lost to the student. In fact, the only experiments in this whole course

which left an impression upon the class, were those with hydrogen and oxygen which some of the students prepared for the professor while he was out of the lecture room. And I think I am not doing the kindly professor an injustice when I say I firmly believe that these experiments were the first to leave lasting impression upon him. Not a word in that whole course in chemistry was said which conveyed to the minds of the students the idea that chemistry was for any other purpose than to be simply dabbled with in college laboratories; not a word was said which conveyed to the minds of the students the fact that the laws and principles which we were studying were the foundation stones of our great industrial structures; not a word which impressed upon us the fact that we were studying the very substances from which our own bodies are made, from which the whole universe is made; not a word concerning the possibilities of the new chemistry; not a word which would indicate that there was anything more in the whole realm of chemistry than that found within the covers of a small elementary text. My surprise was all the greater when a few years later, I sat before a man with a thorough knowledge of industrial and practical chemistry.

The above is a fair sample, I think, of the methods of teaching chemistry in a majority of our state universities twenty-five years ago. In fact, very little progress had apparently been made since the introduction of laboratory work into the United States some twenty-five or thirty years earlier. In 1850 there were, so far as I can learn, only four or five institutions in the country which could boast of a chemical laboratory, and these were equipped in the most primitive way. Yale College had a small laboratory barely large enough to accommodate a dozen students. Amherst

had just opened a small laboratory and Lawrence Scientific School likewise had a very imperfect one. There were, perhaps, two or three other institutions which had so-called chemical laboratories. There were, however, no systematic courses of study such as we find in our universities to-day, and no courses in applied and industrial chemistry. Students who were desirous of a systematic study of chemistry and more especially along technical lines, were forced to go abroad. With the exception of these few institutions the teaching of chemistry was entirely didactic. It is not surprising, therefore, that little or no progress should have been made during the next twenty or thirty years in the teaching of chemistry.

I do not mean to say that there were no great teachers of chemistry during these pioneer days. Such a statement would be incorrect, for there were men who stood out in chemistry during the fifties, sixties and seventies, as prominently in our own country as Liebig and Wöhler did in Germany during the early part of the century. Such men as Silliman and Cook stood out preeminently during the fifties and sixties, while men like Elliott, Remsen, Chandler, Morley, Mabery, Mallet and others have given the institutions with which they were connected such a standing as to place them on the same plane with the older institutions of Europe.

In this early epoch, practically none of the state universities of the center and middle west had reached a point where they could offer to the student good practical courses in chemistry. One reason, I think, was a lack of well-trained teachers, but the chief reason was doubtless an economic one. The state universities turned out few skilled chemists because there was no demand for such men in the center and middle west. The great industrial institu-

tions were not compelled to resort to science and to the reclamation processes in order to earn large dividends. The trained chemist had not yet entered on the industrial stage. He did not hold the great industries in his hand as he does to-day. Furthermore, the state universities were scarcely able to train such men had there been a demand. They were struggling to keep up with the rapidly growing population of the state, and little more could be done than to teach general chemistry in crowded and poorly equipped laboratories. In fact, the state universities of the center and middle west twenty-five years ago were supported by the state as belonging in the same class as reform schools and institutions of similar nature. The state had not yet come to realize that the university is its best investment, not only from the mental and moral but also from the strictly commercial point of view!

The state universities, I think, occupy a position quite different from any of the other educational institutions. They are a part of the great commonwealth, they belong to the people of the state and hence must, if they fulfill their obligations to the state, not only train men and women for civic but also for purely scientific and industrial life. Neither must be neglected. During the past decade practically all of the state universities have come to realize this fact, and nowhere in the world has there been such rapid development along the lines of both pure and applied chemistry as in these institutions. The teaching of chemistry in these rapidly developing states has naturally and properly taken an industrial trend. There is not a single state university to-day which is not, besides doing research work, materially assisting in the industrial development of the state from which it receives its support. It is no longer difficult to obtain appropriations

to well equip laboratories, as is evident from the splendidly equipped laboratories of the University of Illinois.

Of all these great universities which have become not only great educational but also important industrial factors within the bounds of the states from which they receive their support, the University of Illinois stands among the first. Situated in the center of a great industrial population where trained men are always at a premium, its opportunities are boundless. It is bound to play an even more important part in the chemical development of the country in the future than it has in the past. With the man at the head, whom we have gathered here to-day to honor and bid a god-speed, I do not believe it is possible to predict too much for this university not only in purely didactic but also in industrial and applied chemistry. None of the branches of chemistry which must be taken up by this state university are new to him. He is the peer of Elliott or Remsen in didactics and of Silliman and Chandler in industrial chemistry. No man in the whole country is better fitted to take up the broad lines of chemistry now demanded by the state university. I congratulate the University of Illinois and the whole state in securing Dr. Noyes as standard bearer, and with such coworkers as Parr, Grindley, Bartow, Lincoln and Curtiss, this university will stand second to none of the state universities in preparing young men and women for the work demanded by this great state and by the whole nation.

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*THE CONTRIBUTION OF CHEMISTRY TO
MODERN LIFE*

I THINK that few who have not paid especial attention to the subject realize how completely the world, as a place to live in,